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Evaluate the Impact of Ternary Fuel Blends and the Addition of Cerium Oxide on the Performance and Emission Characteristics of IC Engines

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ABSTRACT: This study investigates the impact of Cerium Oxide (CeO2) nanoparticles as fuel-borne additives on the performance and emissions of a ternary fuel blend utilized in a single cylinder Direct Injection (DI) diesel engine. The ternary fuel (TF) comprises 70% diesel, 20% Soyabean biodiesel, and 10% ethanol. Experimental tests were conducted under varied load conditions (25%, 50%, 75%, and 100% load) while maintaining a constant speed of 1500 rpm. Cerium Oxide nanoparticles were incorporated into the TF at concentrations of 30, 45, and 60 ppm. Results reveal that TF blended with 45 ppm Cerium Oxide (TF45) exhibited notable improvements in brake thermal efficiency (BTE) and reduced brake-specific fuel consumption (BSFC) by 5.74% and 7.69% respectively, in comparison to Pure Diesel. Additionally, TF45 demonstrated decreased emissions of Hydrocarbons (HC), Carbon monoxide (CO), Nitrogen oxides (NOx), and Carbon dioxide (CO2) by 25.53%, 41.34%, 23.68%, and 25.66% respectively, at full load. The findings suggest that incorporating 45 ppm Cerium Oxide nanoparticles into ternary fuel (TF) has the potential to enhance engine performance and concurrently reduce exhaust pollutants, presenting a promising avenue for sustainable and efficient diesel engine operation.

KEYWORDS: Cerium oxide. Ternary fuel. Engine performance. Emission

I. INTRODUCTION

The paper investigates the impact of Cerium Oxide (CeO2) nanoparticles as fuel additives on a ternary fuel blend used in a single cylinder DI diesel engine. This blend comprises 70% diesel, 20% Soyabean biodiesel, and 10% ethanol. The study focuses on engine performance and emissions under varying load conditions. Experimental results show that TF blended with 45 ppm CeO2 nano additive significantly improves brake thermal efficiency (BTE), reduces brake-specific fuel consumption (BSFC), and decreases emissions of hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), and carbon dioxide (CO2) compared to pure diesel.

II. LITRATURE REVIEW

This survey for the paper focusing on the effects of fuel-borne additives, specifically Cerium Oxide (CeO2) nanoparticles, on the performance and emissions of a ternary fuel blend in a diesel engine:

Previous Studies on Diesel Engine Performance with Additives: Numerous studies have investigated the use of additives to improve diesel engine performance and emissions. Research has explored various types of additives, including nanoparticles, oxygenates, and surfactants, to enhance combustion efficiency, reduce emissions, and mitigate engine wear.

Cerium Oxide (CeO2) Nanoparticles as Fuel Additives: Cerium Oxide nanoparticles have gained attention in recent years due to their unique properties, such as high surface area, oxygen storage capacity, and catalytic activity. Previous research has demonstrated the potential of CeO2 nanoparticles as fuel additives to enhance combustion efficiency and reduce emissions in diesel engines.

Effects of Nanoparticles on Combustion: Studies have shown that the addition of nanoparticles to fuel can improve combustion characteristics by promoting more complete fuel oxidation, enhancing flame propagation, and reducing ignition delay. CeO2 nanoparticles, in particular, have been reported to act as oxygen carriers, facilitating more efficient combustion of hydrocarbon fuels.

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Impact of Ternary Fuel Blends: Ternary fuel blends, such as those containing diesel, biodiesel, and ethanol, have been investigated as a means to reduce dependency on fossil fuels and mitigate environmental pollution. Previous studies have evaluated the performance and emissions characteristics of ternary fuel blends in diesel engines under various operating conditions.

Performance and Emissions Optimization: Research has focused on optimizing engine performance and emissions by adjusting fuel composition and incorporating additives. Studies have explored the synergistic effects of fuel blends and additives on combustion efficiency, thermal efficiency, and pollutant emissions, aiming to identify optimal fuel formulations for diesel engines.

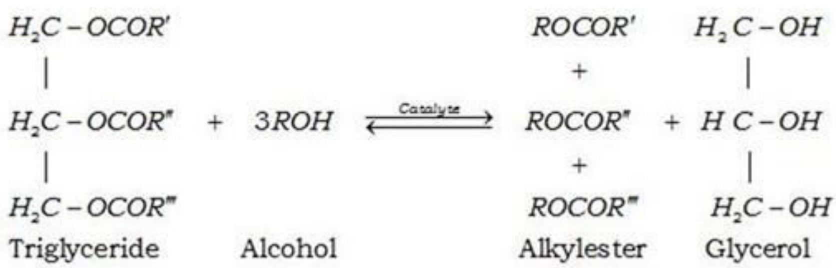
Experimental Methodologies: Literature has documented various experimental methodologies for evaluating the effects of fuel additives on diesel engine performance and emissions. These methodologies include engine dynamometer testing, exhaust gas analysis, and emissions measurement techniques such as smoke opacity, particulate matter, and nitrogen oxide (NOx) analysis.

Challenges and Limitations: Despite the potential benefits of fuel additives, challenges and limitations exist in their implementation, including concerns related to additive stability, compatibility with engine components, and potential long-term effects on engine durability and emissions control systems. Research has addressed these challenges through rigorous testing and characterization of additive-fuel interactions.

III. MATERIAL AND METHODS

Preparation of biodiesel:

Transesterification process is one of the most commonly used method to produce biodiesel.



In transesterification 180 ml of methanol & 10 g of KOH dissolved in soybean oil & ethanol by keeping the flask on magnetic stirrer.

Fig. Soyabean Oil

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Initially raw oil of soybean and ethanol heated at 100^{0}C continuously using a heater after heating allow to cool at 60^{0}C. The cooled mixture of oil kept by maintaining temperature 60^{0}C.

Fig. Mixture of methanol+potassium hydroxide

After that prepare a mixture of methanol+ potassium hydroxide and the mixture stirred for half an hour without heating While preparing a mixture of methanol and KOH for 1liter of oil 180 ml of methanol and 10 grams of KOH required after preparation of a mixture stirring it continuously using magnetic stirrer

If there will be 2 liter of oil then the concentration of methanol + KOH will be double ie is 360 ml of methanol & 20 gram of KOH.

Then the prepared mixture of methanol & KOH add in the soybean oil & ethanol which was maintained at 60^{0}C, the addition of mixture will be manually and the mixture heat continuously 1 hour at 60^{0}C by using a heater to ensure complete transesterification reaction, continuous heating of solution causes methanol get evaporated through condenser Then the mixture kept for several hours nearly 12 hours in a separating funnel , a two distinct layer will form because of density variation of biodiesel and glycerol due to gravity settling.

Fig. Soyabean biodiesel separation

The biodiesel layer form at upper due to low density & glycerol settled down due high density as compared to biodiesel.

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Fig: Preparation of blend by adding nanoparticle in biodiesel.

To prepare a fuel blend by adding nanoparticle in biodiesel according to number of blend using magnetic stirrer and an ultrasonicator. The ultrasonication method was performed at frequency of 120 w for 30 min duration. This process is displaced in above fig. Preparation of first blend 30 milligram nanoparticle weighed & added in beaker in presence of 20% of soybean+10% ethanol+70%diesel then beaker kept about 30 min in ultrasonicator to disperse the particle of nanoparticles or to ensure proper mixing of nanoparticle.Preparation of second blend 45 milligram nanoparticle weighed & added in beaker in presence of 20% of soybean+10% ethanol+70%diesel then beaker kept about 30 min in ultrasonicator to disperse the particle of nanoparticles or to ensure proper mixing of nanoparticle.Preparation of first blend 60 milligram nanoparticle weighed & added in beaker in presence of 20% of soybean+10% ethanol+70%diesel then beaker kept about 30 min in ultrasonicator to disperse the particle of nanoparticles or to ensure proper mixing of nanoparticle.

IV. PROPERTY ANALYSIS OF CERIUM OXIDE-BLENDED TERNARY FUEL WITH PURE DIESEL

Sample/Properties	**Density**	**LCV Calorific Value**	**HCV Calorific Value**	**Flash point**	**Fire point**	**Kinematic Viscosity**	**Dynamic Viscosity**
Unit	kg/m3	cal/gm	cal/gm	°C	°C	cst	cp
D100	820	10000	10856	47	58	2.06	1.69
D70+20%SoyBD+10%EtOH45ppm Ceo2	824	9691	10277	59	63	2.89	2.38

V. EXPERIMENTAL SETUP

We're testing a single-cylinder diesel engine made by Kirloskar, typically used in farming. It produces 3.5 kW of power at a steady speed of 1500 rpm. The engine has a size of 661 cm3 and uses direct injection. Key specs include a 17:5 compression ratio, injection timing of 23 degrees before top dead center, injection pressure of 200 bar, and runs at 1500 rpm.For testing, we use MICO fuel injection and a pressure sensor to measure in-cylinder pressure. An exhaust gas

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analyzer and smoke meter track emissions. The engine is connected to a dynamometer to vary load. Tests are done at 25%, 50%, 75%, and 100% load.

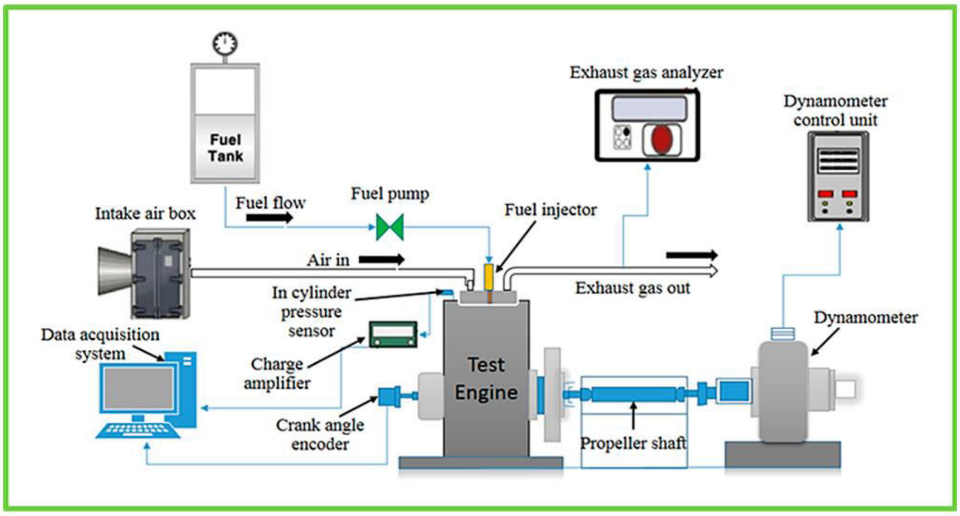

FIG. EXPERIMENTAL ENGINE SETUP

Engine Details : Cylinder	1
Stork	4
Cylinder Diameter	87.50 (mm)
Stork length	110 (mm)
Connecting rod length	234 (mm)
Orifice diameter	20 (mm)
Dynamometer arm length	185 (mm)
Power	3.50 kw
Speed	1500 Rpm
Compression ratio	17:5
Swept value	661.45cc

Preformance Parameters :

Brake-specific fuel consumption (BSFC) is a measure of the fuel efficiency of any prime mover that burns fuel and produces rotational, or shaft power. It is typically used for comparing the efficiency of internal combustion engines with a shaft output. BSFC represents the rate of fuel consumption divided by the power produced**.**(TF30): As graph represents at load 25, 50, 75, BSFC is been decreased by 27.84%, 8.16%, 10%, but at load 100 it is increased by 15.38 when compared with diesel (D100) (TF45): As graph represents at load 25, 50, 75, 100, BSFC is been decreased by 30.37%, 12.24%, 7.5%, 7.69% when compared with diesel (D100).(TF60): As graph represents at load 25, 50, 75, 100, BSFC is been decreased by 26.58%, 18.36%, 10%, 2.56% when compared with diesel (D100).

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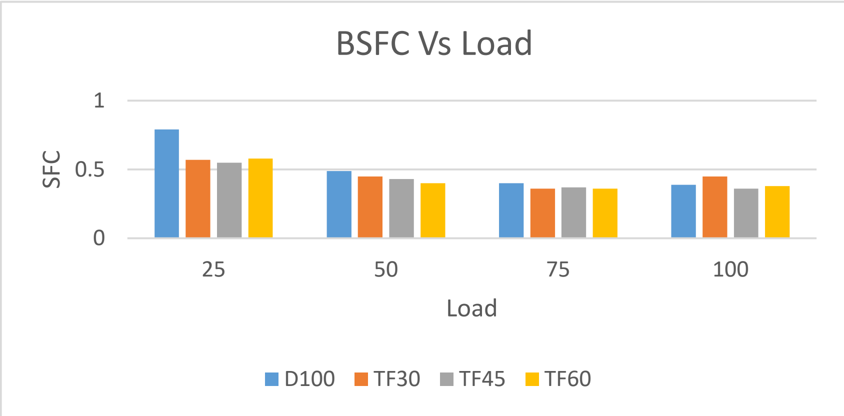

Fig. BSFC VS Load

Brake Thermal Efficiency (BTE) is a crucial metric in the realm of internal combustion engines. It quantifies how efficiently an engine converts the heat energy from fuel into useful work. Specifically, BTE represents the ratio of the useful work output of the engine to the heat energy input derived from the combustion of fuel. In simpler terms, it measures how effectively an engine transforms fuel into power.(TF30): As graph represents at load 25, 50, 75, BET is been increased by 39.11%, 8.27%, 9.31%, but at load 100 it is decreased by 26.56% when compared with diesel (D100).(TF45): As graph represents at load 25, 50, 75, 100, BET is been increased by 43.74%, 15.39%, 8.94%, 6.09% when compared with diesel (D100).(TF45): As graph represents at load 25, 50, 75, BET is been increased by 36.42%, 21.59%, 10.37%, at load 100 it is decreased by 0.04% when compared with diesel (D100).

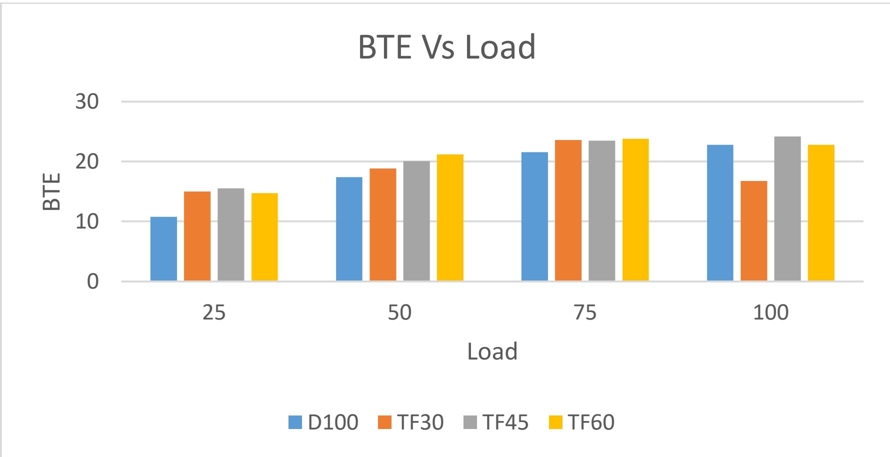

Fig. BTE VS Load

Emissions Results :

NOx Emission :

In the study, the addition of 45 ppm Cerium Oxide nanoparticles to the ternary fuel blend resulted in a decrease in NOx emissions by 23.68% compared to pure diesel fuel at full load conditions.

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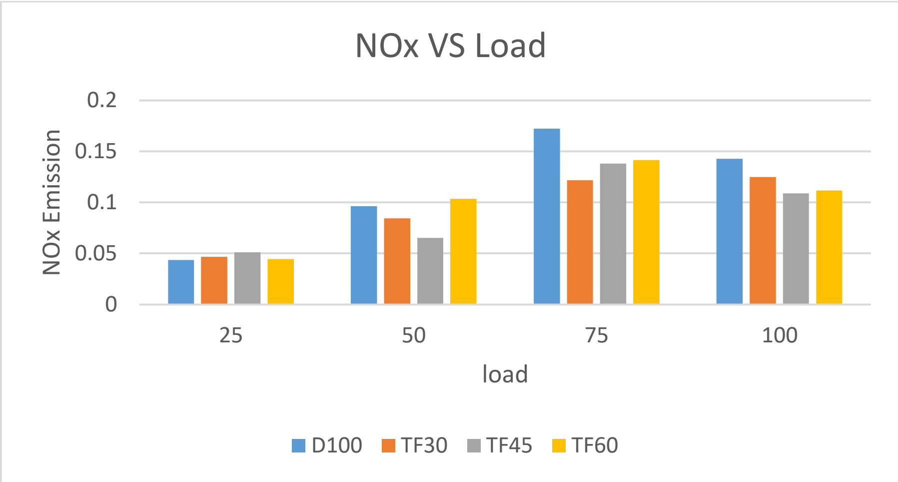

Fig. NOx VS Load

CO2 Emissions:

TF30: At load 50 emission are increased by 24% and at load 25, 75, and 100 emissions are decreased by 12.19%, 18.4% and 9.73% when compared with diesel (D100). The CO_2 emissions are constant across all loads at approximately 5 units of CO_2.TF45: At load 25, 50, 75, and 100 emissions are decreased by 2.43%, 4%, 10.86% and 25.66% when compared with diesel (D100). The emissions are also constant across all loads but slightly higher than TF30, staying around the mark of just below 10 units of CO_2.TF60:

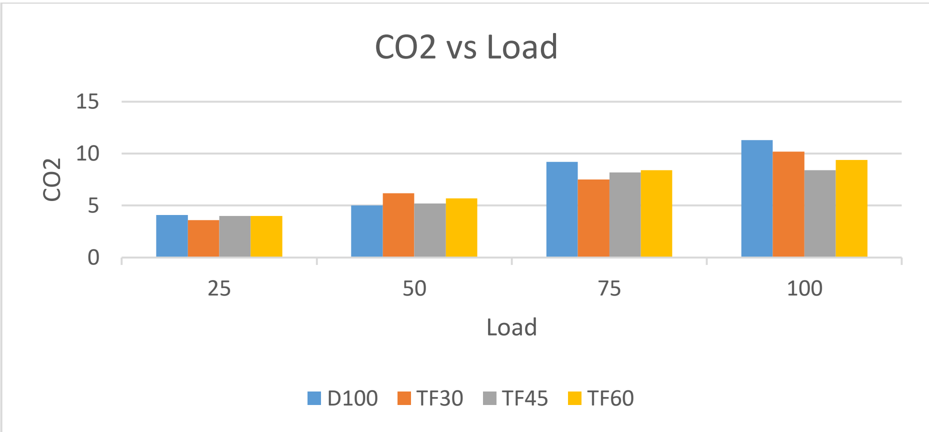

Fig. CO2 VS Load

HC Emission :

(TF30): At load 50 emission are increased by 53.84% and at load 25, 75, and 100 emissions are decreased by 0%, 21.42% and 10.63% when compared with diesel (D100). At a load of 25, the HC emission is lower than D100 but still significant. As the load increases, TF30 shows a gradual increase in HC emissions.(TF45): At load 25 and 50 emission are increased by 22.22% and 46.15% and at load 75, and 100 emissions are decreased by 7.14% and 25.53% when compared with diesel (D100). At a load of 25, the HC emission is lower than both D100 and TF30. As the load increases, TF45 exhibits a moderate rise in HC emissions.(TF60): At load 25 and 50 emission are increased by 14.81% and 57.69% and at load 75, and 100 emissions are decreased by 1.78% and 3.19% when compared with diesel (D100). At a load of 25, the HC emission is the lowest among all types. As the load increases, TF60 shows a gradual increase in HC emissions, but it remains lower than other types.

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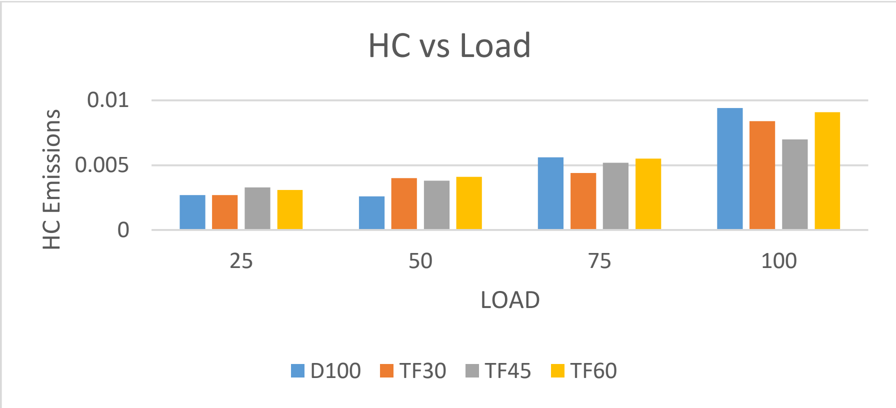

Fig. HC VS Load

CO Emission :

The addition of 45 ppm Cerium Oxide (CeO2) nano additives to the ternary fuel blend resulted in a reduction of carbon monoxide (CO) emissions by 41.34% compared to pure diesel.

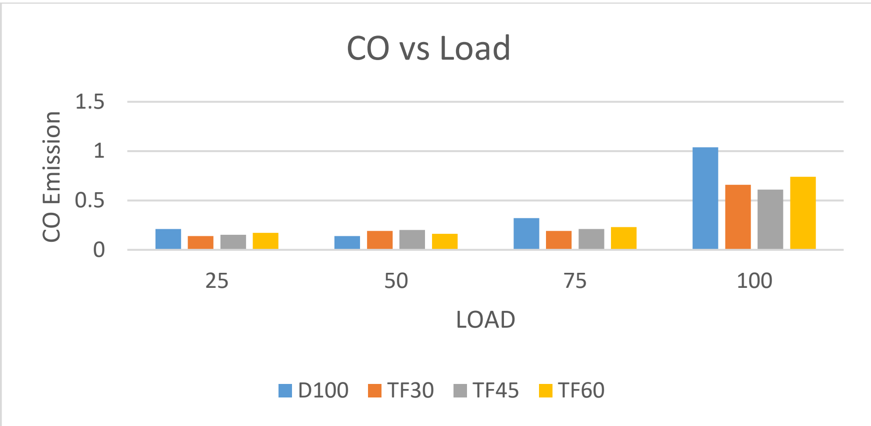

Fig. CO VS Load

VI. CONCLUSION

Incorporating 45 ppm Cerium Oxide (CeO2) nano additives into a ternary fuel blend (TF) improves engine performance and reduces emissions. TF45 showed enhanced brake thermal efficiency (BTE) and reduced brake-specific fuel consumption (BSFC) compared to pure diesel. Additionally, TF45 demonstrated decreased emissions of HC, CO, NOx, and CO2. Therefore, adding 45 ppm CeO2 to TF enhances engine performance and reduces exhaust pollutants, particularly at full load conditions.

REFERENCES

1.Harish venu1 an experimental assessment on the influence of fuel-borne additives on ternary fuel (diesel–biodiesel–ethanol) blends operated in a single cylinder diesel engine. Environmental science and pollution research https://doi.org/10.1007/s11356-019-04739-5.

2.Ramesh babu allmouth , Getachew Alemayehu Rajendran performance and emission evaluation of ci engine fuelled with ethanol diesel emulsion using Niznfe2O4 nanoparticle additive heliyon https://doi.org/10.1016/j.heliyon.2022.e11639.

3.Anurag Udoji experimental investigation into effects of addition of zinc oxide on performance combustion and emission characteristics of diesel-biodiesel-ethanol blends in ci engine alexandria engineering journal http://dx.doi.org/10.1016/j.aej.2016.08.022.

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| DOI:10.15680/IJMRSET.2024.0705139 |

4.Velraj influence of alumina nanoparticles, ethanol and isopropanol blend as additive with diesel soybean biodiesel blend fuel: combustion ,engine performance and emissions renewable energy http://dx.doi.org/10.1016/j.renene.2015.02.042.

5.Om Prakash, Rajnish Kumar Chourasia performance and emissions of compression ignition engine fueled with ethanol diesel blend journal European des systems automatises https://doi.org/10.18280/jesa.520214.

6. Amit pal blending of ethanol in gasoline: impact on si engine performance and emissions international journal of thermal technologies http://dx.doi.org/10.14741/ijtt/mar.2014.01.

7.Campli srinidhi1 | a. Madhusudhan1 | s. V. Channapattana2 | Shivaji v. Gawali1, comparative investigation of performance add emission features of methanol, ethanol, Dee, and nanoparticles as fuel additives in diesel-biodiesel blends. Heart transfers willy . Gamali http://orcid.org/0000-0002-6503-8937 .

8.t. Shaafi, r. Velraj influence of alumina nanoparticles, ethanol and isopropanol blend as additive with diesel soybean biodiesel blend fuel: combustion, engine performance and emissions an experimental reserved. Renewable energy. Http://dx.doi.org/10.1016/j.renene.2015.02.042.

9.s. Janakiraman, t. Lakshmanan, p. Raghu, dr. Experimental investigative analysis of ternary (diesel + biodiesel + bio-ethanol) fuel blended with metal-doped titanium oxide nano additives tested on a diesel engine. Journal pre-proof. Https://doi.org/10.1016/j.energy.2021.121148 .

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